ENGINEERING CHANGE NOTICE

1. ECN 635534

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. USQ Required?	5. Date
Supplemental [] Direct Revision [X] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	John H. Baldwin, Data Assessment and Interpretation, R2-12, 373-4533	[] Yes [X] No	08/07/97
	6. Project Title/No./Work Order No.	7. Bldg./Sys./Fac. No.	8. Approval Designator
	Tank 241-T-102	241-T-102	N/A
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.)	10. Related ECN No(s).	11. Related PO No.
	HNF-SD-WM-ER-700, Rev. 0	N/A	N/A

12a. Modification Work	12b. Work Package No.	12c. Modification Work Complete	12d. Restored to Original Condition (Temp. or Standby ECN only)
[] Yes (fill out Blk. 12b) [X] No (NA Blks. 12b, 12c, 12d)	N/A	N/A Design Authority/Cog. Engineer Signature & Date	N/A Design Authority/Cog. Engineer Signature & Date

13a. Description of Change

13b. Design Baseline Document? [] Yes [X] No

This ECN was generated to include additional explanatory text in the best-basis narrative, and to update the comprehensive radionuclide inventory estimates for the tank.

14a. Justification (mark one)

Criteria Change	[]	Design Improvement	[X]	Environmental	[]	Facility Deactivation	[]
As-Found	[]	Facilitate Const	[]	Const. Error/Omission	[]	Design Error/Omission	[]

14b. Justification Details

Initial release of this document was deficient.

15. Distribution (include name, MSIN, and no. of copies)

See attached distribution.

RELEASE STAMP

DATE: AUG 25 1997

STA: 4

HANFORD RELEASE

ID: 3

ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1) ECN-635534

16. Design Verification Required	17. Cost Impact				18. Schedule Impact (days)	
	ENGINEERING		CONSTRUCTION			
[] Yes	Additional	[] $	Additional	[] $	Improvement	[]
[X] No	Savings	[] $	Savings	[] $	Delay	[]

19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 13. Enter the affected document number in Block 20.

SDD/DD	[]	Seismic/Stress Analysis	[]	Tank Calibration Manual	[]
Functional Design Criteria	[]	Stress/Design Report	[]	Health Physics Procedure	[]
Operating Specification	[]	Interface Control Drawing	[]	Spares Multiple Unit Listing	[]
Criticality Specification	[]	Calibration Procedure	[]	Test Procedures/Specification	[]
Conceptual Design Report	[]	Installation Procedure	[]	Component Index	[]
Equipment Spec.	[]	Maintenance Procedure	[]	ASME Coded Item	[]
Const. Spec.	[]	Engineering Procedure	[]	Human Factor Consideration	[]
Procurement Spec.	[]	Operating Instruction	[]	Computer Software	[]
Vendor Information	[]	Operating Procedure	[]	Electric Circuit Schedule	[]
OM Manual	[]	Operational Safety Requirement	[]	ICRS Procedure	[]
FSAR/SAR	[]	IEFD Drawing	[]	Process Control Manual/Plan	[]
Safety Equipment List	[]	Cell Arrangement Drawing	[]	Process Flow Chart	[]
Radiation Work Permit	[]	Essential Material Specification	[]	Purchase Requisition	[]
Environmental Impact Statement	[]	Fac. Proc. Samp. Schedule	[]	Tickler File	[]
Environmental Report	[]	Inspection Plan	[]		[]
Environmental Permit	[]	Inventory Adjustment Request	[]		[]

20. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number Revision
N/A		

21. Approvals

Signature	Date	Signature	Date
Design Authority		Design Agent	
Cog. Eng. J.H. Baldwin John Baldwin	8/20/97	PE	
Cog. Mgr. K.M. Hall Kathleen M. Hall	8/20/97	QA	
QA		Safety	
Safety		Design	
Environ.		Environ.	
Other		Other	
		DEPARTMENT OF ENERGY	
		Signature or a Control Number that tracks the Approval Signature	
		ADDITIONAL	

Tank Characterization Report for Single-Shell Tank 241-T-102

John H. Baldwin
Lockheed Martin Hanford, Corp., Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

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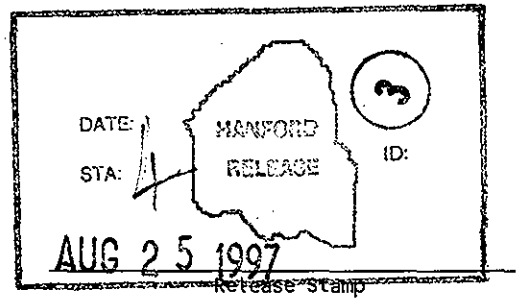
Key Words: Waste Characterization, Single-Shell Tank, SST, Tank 241-T-102, 241-T-102, T-102, T Farm, Tank Characterization Report, TCR, Waste Inventory, TPA Milestone M-44

Abstract: This document summarizes the information on the historical uses, present status, and the sampling and analysis results of waste stored in Tank 241-T-102. This report supports the requirements of the Tri-Party Agreement Milestone M-44-05.

Release Approval 8/22/97 Date



Release Stamp

Approved for Public Release

RECORD OF REVISION	(1) Document Number HNF-SD-WM-ER-700	Page 1

(2) Title
Tank Characterization Report for Single-Shell Tank 241-T-102

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release	
		(5) Cog. Engr.	(6) Cog. Mgr. Date
0	(7) Initially released 06/24/97 on EDT-617655.	J.H. Baldwin	K.M. Hall
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		John Baldwin	Kathleen M. Hall 8/20/97

3.0 BEST-BASIS INVENTORY ESTIMATE

Information about the chemical and/or physical properties of tank wastes is used to perform safety analyses, engineering evaluations, and risk assessments associated with waste management activities, as well as to address regulatory issues. Waste management activities include overseeing tank farm operations and identifying, monitoring, and resolving safety issues associated with these operations and with the tank wastes. Disposal activities involve designing equipment, processes, and facilities for retrieving wastes and processing the wastes into a form that is suitable for long-term storage.

Chemical inventory information generally is derived using two approaches: 1) component inventories are estimated using the results of sample analyses; and 2) component inventories are predicted using a model based on process knowledge and historical information. The most recent model was developed by Los Alamos National Laboratory (LANL) (Agnew et al. 1997). Not surprisingly, information derived from these two different approaches is often inconsistent.

An effort is underway to provide waste inventory estimates that will serve as standard characterization information for the various waste management activities (Hodgson and LeClair 1996). Appendix D contains the complete narrative regarding the derivation of the inventory estimates presented in Tables 3-1 and 3-2.

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-T-102 (February 11, 1997). (2 Sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1]	Comment
Al	38,500	S	Tank 241-T-102 Sample Results
Bi	<716	S	
Ca	95.1	S	
Cl	70.3	S	
CO_3	3,690	S	
Cr	188	S	
F	42	S	
Fe	2,330	S	
Hg	0.8	S	
K	<530	S	
La	<71.6	S	
Mn	123	S	

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-T-102 (February 11, 1997). (2 Sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1]	Comment
Na	7,215	S	
Ni	9.00	S	
NO_2	2,160	S	
NO_3	9,870	S	
OH	<3.1	S	
Pb	247	S	
P as PO_4	805	S	
Si	417	S	
S as SO_4	443	S	
Sr	<7.2	S	
TOC	106	S	
U_{TOTAL}	<2,860	S	
Zr	<14.3	S	

Notes:

[1]S = sample-based, M = HDW model-based, E = engineering assessment-based.

Table 3-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-T-102 Decayed to January 1, 1994 (Effective May 31, 1997). (3 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M, or E)[1]	Comment
^{3}H	0.9	S	
^{14}C	5.9	S	
^{59}Ni	0.00214	M	
^{60}Co	<879	S	
^{63}Ni	0.206	M	
^{79}Se	0.00165	M	
^{90}Sr	30690	S	
^{90}Y	30690	S	based on ^{90}Sr

Table 3-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-T-102 Decayed to January 1, 1994 (Effective May 31, 1997). (3 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M, or E)[1]	Comment
^{93m}Nb	0.00603	M	
^{93}Zr	0.00779	M	
^{99}Tc	2.3	S	
^{106}Ru	1.20 E-05	M	
^{113m}Cd	0.0306	M	
^{125}Sb	0.0398	M	
^{126}Sn	0.0025	M	
^{129}I	1.04 E-04	M	
^{134}Cs	<1.5	S	
^{137m}Ba	6900	S	based on ^{137}Cs
^{137}Cs	7300	S	
^{151}Sm	6.04	M	
^{152}Eu	0.0426	M	
^{154}Eu	63	S	
^{155}Eu	70	S	
^{226}Ra	1.11 E-06	M	
^{227}Ac	0.0106	M	
^{228}Ra	0.00346	M	
^{229}Th	0.00157	M	
^{231}Pa	0.0157	M	
^{232}Th	1.61 E-04	M	
^{232}U	0.179	M	
^{233}U	0.694	M	
^{234}U	1.97	M	
^{235}U	0.0851	M	
^{236}U	0.0347	M	
^{237}Np	0.07	S	
^{238}Pu	4	M	
^{238}U	1.93	M	
^{239}Pu	7.4	S	
^{240}Pu	29.6	M	
^{241}Am	32.9	S	

Table 3-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-T-102 Decayed to January 1, 1994 (Effective May 31, 1997). (3 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M, or E)[1]	Comment
^{241}Pu	320	M	
^{242}Cm	6.11 E-04	M	
^{242}Pu	9.01 E-04	M	
^{243}Am	3.32 E-07	M	
^{243}Cm	0.16	S	
^{244}Cm	1.26 E-05	M	

[1]S=Sample-based
M=Hanford Defined Waste model-based
E=Engineering assessment-based

APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS STANDARD INVENTORY FOR TANK 241-T-102

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APPENDIX D

BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-T-102

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities. As part of this effort, an evaluation of available information for tank 241-T-102 was performed, and a best-basis inventory was established. This work, detailed in the following sections, follows the methodology that was established by the standard inventory task.

D1.0 CHEMICAL INFORMATION SOURCES

This section describes the sampling campaign that was performed to establish the waste composition profile in tank 241-T-102 (Pool 1993). In 1993, two push mode core samples were obtained from risers 2 and 8 of tank 241-T-102, while three supernatant grab samples were taken from riser from 2 in July, 1994. Core 55, from riser 2, contained only a small amount of material (80.59 g), while core 56, from riser 8, consisted of so little material (8.42 g) that the core was placed into archive for later analysis. This section also discusses the HDW model estimates of the waste composition profile based on process records and transaction records for the tank.

D2.0 COMPARISONS OF COMPONENT INVENTORY VALUES

Based on the sample sludge level (12.7 cm), tank 241-T-102 apparently contains about 99.5 kL (26.3 kgal) of waste, including 47.3 kL (12.5 kgal) in the dished bottom of the tank. All of this waste evidently consists of sludge, with only a minimal amount of drainable liquid (13 volume percent). Based on these values, the waste consists of 86.6 kL (22.9 kgal) of sludge and 12.9 kL (3.4 kgal) of drainable liquid. This inventory is about 21.7 percent lower than the tank farm surveillance estimate of 121.1 kL (32 kgal), which consists of 71.9 kL (19 kgal) of sludge and 49.2 kL (13 kgal) of drainable liquid or supernatant (Hanlon 1997).

From a study of a photographic montage of the tank's interior, it appears that most of the drainable liquid or supernatant exist in the center of the tank, while the risers from which the samples were taken are located around the periphery of the tank. Therefore, the sludge level is nonuniform and probably concave in the middle following the dished bottom profile of the tank. Based on these observations, the actual sludge volume could vary from as little as 52.2 kL to the Hanlon value of 71.9 kL (19 kgal).

For the purpose of this analysis, the best-basis inventory will be developed from Hanlon 1997 estimates (71.9 kL of sludge and 49.2 kL of supernatant). Because TCR inventories are based only on the composition of the sludge, the best basis inventory estimates will be higher for certain components, such as Al, NO_3, NO_2 and Na, because of the added supernatant contribution for these components.

Table D2-1 provides a summary of the composite sludge and supernatant analytical values and tank inventory estimates developed from the sludge volume and sample density data (71.9 kL [19 kgal] and 1.79 kg/L, respectively), and supernatant volume and density data (49.2 kL (13 kgal) and 1.1 kg/L, respectively). (The chemical species are reported without charge designation per the best-basis inventory convention). The supernatant composition is based on a 1994 supernatant sample from this tank. Because saltwell pumping was the only activity that occurred after 1974, the 1994 supernatant sample should represent the general composition of the excess supernatant in this tank.

Table D2-1. Analytical Results and Sludge Inventory Estimates for Nonradioactive Components in Tank 241-T-102. (3 Sheets)

Component	Mean Sludge Concentration in 1993 Core[1] (μg/g)	Mean Supernatant Concentration in 1994[2] (μg/mL)	Total Tank Inventory[3] (kg)
Al	299,000	NR	38,500
Sb	<556	NR	<71.6
As	890	NR	115
Ba	<111	NR	<14.3
Be	<55.6	NR	<7.16
Bi	<5,560	NR	<716
B	356	NR	45.8
Cd	249	NR	32
Ca	739	NR	95.1
Ce	<1,110	NR	<143
Cl	300	644	70.3
Cr	787	1,760	188
Co	<111	NR	<14.3
CN	4.15	NR	0.53
Cu	57.5	NR	7.4
Dy	<556	NR	<71.6

Table D2-1. Analytical Results and Sludge Inventory Estimates for Nonradioactive Components in Tank 241-T-102. (3 Sheets)

Component	Mean Sludge Concentration in 1993 Core[1] (μg/g)	Mean Supernatant Concentration in 1994[2] (μg/mL)	Total Tank Inventory[3] (kg)
Eu	<2,200	NR	<283
F	220	278	42
Fe	18,100	NR	2,330
Gd	<5,560	NR	<716
La	<556	NR	<71.6
Pb	1,920	NR	247
Li	<334	NR	<43.0
Mg	<1,110	NR	<143
Mn	957	NR	123
Hg	6.25	NR	0.8
Mo	<334	15.1	<43.7
Nd	1,620	NR	209
Ni	68	NR	8.75
NO_3	35,000	109,000	9,867
NO_2	8,000	23,000	2,161
OH	NR	<62.5	<3.1
Pd	<3,340	NR	<429
P as PO_4	4,689	4,100	805.2
K	<4,000	318	<530
Rh	<3,340	NR	<429
Ru	<2,220	NR	<286
Se	<1,110	NR	<143
Si	3,240	NR	417
Ag	<111	NR	<14.3
Na	31,400	64,500	7,215
Sr	<55.6	NR	<7.2
SO_4	1,570	4,890	443
Te	<5,560	NR	<716

Table D2-1. Analytical Results and Sludge Inventory Estimates for Nonradioactive Components in Tank 241-T-102. (3 Sheets)

Component	Mean Sludge Concentration in 1993 Core[1] (μg/g)	Mean Supernatant Concentration in 1994[2] (μg/mL)	Total Tank Inventory[3] (kg)
Tl	<5,560	NR	<716
Th	<8,900	NR	<1,150
Sn	<11,100	NR	<1,430
Ti	60	NR	7.7
TIC as CO_3	17,300	29,700	3,688
TOC	655	449	106.4
W	<2,220	NR	<286
U	<22,200	NR	<2,860
V	<111	NR	<14.3
Zn	802	NR	103
Zr	<111	NR	<14.3
Density	1.79 g/mL	1.14 g/mL[3]	

Notes:

[1]Mean sludge concentrations for core 55 from the TCR (Pool 1993).

[2]Supernatant composition from 1994 grab sample.

[3]Tank inventory based on 71.9 kL of sludge with an average density of 1.79 kg/L, and 49.2 kL of supernatant with a density of 1.14 kg/L.

Table D2-2 provides a summary of the mean composite sludge and supernatant radionuclide concentrations and tank inventory estimates based on the 1993 core sample and 1994 supernatant grab sample from this tank. Radionuclide results in Table D2-2 are reported as mean values and have been decayed to January 1, 1994.

Table D2-2. Analytical Results and Tank Inventory Estimates for Radioactive Components in Tank 241-T-102 (Decayed to January 1, 1994, Except Total Alpha, Beta and Gamma)[1].

Radionuclide	1993 Core[1] (μCi/g)	1994 Supernatant[2] (μCi/ml)	Tank Inventory[3] (Ci)
^{3}H	0.007	NR	0.9
^{14}C	0.046	NR	5.9
^{60}Co	0.028	<17.8	<879
^{90}Sr	238	1.24	30,690
^{99}Tc	0.018	NR	2.3
^{103}Ru	<0.88	NR	113
^{106}Ru	<0.155	NR	<19.9
^{134}Cs	<0.012	NR	<1.5
^{137}Cs	31.9	64.9	7,299
^{144}Ce	<0.13	NR	<16.7
^{154}Eu	0.49	NR	63.1
^{155}Eu	0.54	NR	69.5
^{237}Np	5.4E-04	NR	0.07
$^{239/240}Pu$	0.055	6.3E-03	7.4
$^{243/244}Cm$	1.25E-03	NR	0.16
^{241}Am	0.256	<4.17E-03	32.9
Total Alpha	0.229	NR	29.5
Total Beta	489	NR	62,930

Notes:

[1]Based on decayed mean of core 55 (Pool 1993).

[2]Based on mean of 1994 supernatant grab sample.

[3]Tank inventory based on 71.9 kL (19 kgal) of sludge and 49.2 kL (13 kgal) of supernatant, with densities of 1.79 kg/L and 1.1 kg/L, respectively.

D3.0 COMPONENT INVENTORY EVALUATION

Sample-based estimates developed from analytical data and HDW model estimates from Los Alamos National Laboratory (LANL) (Agnew et al. 1996) are both potentially useful for estimating component inventories in the tank. The HDW model is mainly based on process production records and waste transaction records for each tank. Primary wastes are process wastes added directly from a plant to tank 241-T-102, while secondary wastes are transferred to the tank from another tank. A review of these records shows that tank 241-T-102 received the following wastes (Agnew 1997a):

- 7,907 kL (2,089 kgal) of secondary $BiPO_4$ metal waste (MW) from tank 241-T-101, most of which was later sluiced for Uranium Recovery (UR).
- 1,836 kL (485 kgal) of secondary plutonium uranium extraction (PUREX) coating waste (CWP2) from tank 241-C-102.
- 1,851 kL (489 kgal) of secondary B-Plant cesium recovery (CSR) ion exchange effluent from tank 241-T-101 through tank 241-BX-101 and tanks 241-BX-101/241-SX-105/241-SX-106/241-SX-114 (a five tank 241-Transfer to tank 241-T-101).

Based on analysis of the original supernatant inventories and source of wastes in the five tank 241-Transfer, 88.4 volume percent of the waste transferred to tank 241-T-101 consists of CSR-IX waste from tank 241-BX-101, 4.3 volume percent consists of REDOX high level (R) waste supernatant from tank 241-SX-114 and 5.2 volume percent consists of REDOX coating waste (CWR) supernatant.

The HDW model (Agnew et al. 1996) assumes that 71.9 kL (19 kgal) of sludge and 49.2 kL (13 kgal) of supernatant have accumulated in tank 241-T-102, including:

- 7.6 kL (2 kgal) of $BiPO_4$ metal waste (MW) sludge
- 64.3 kL (17 kgal) of PUREX coating waste (CWP2) sludge
- 49.2 kL (13 kgal) of supernatant.

The sludge and supernatant inventories developed from the HDW model are consistent with the tank farm surveillance data for this tank (121.1 kL or 32 kgal of sludge and supernatant) (Hanlon 1997). Table D3-1 compares the sample-based and HDW model estimates for chemical components, while Table D3-2 provides a similar comparison for radioactive components in tank 241-T-102. These values are presented to three significant figures.

Table D3-1. Comparison of Sample-Based and Hanford Defined Waste Model Inventory Estimates for Nonradioactive Components in Tank 241-T-102.

Analyte	Sample-based Inventory[1] (kg)	HDW Model-based Inventory (kg)
Al	38,500	10,200
Bi	<716	0
Ca	95.1	853
Cl	70.3	19.6
CO_3	3,690	2,100
Cr	188	8.3
F	42	0
Fe	2,330	1,690
Hg	0.8	76.3
K	<530	4.7
La	<71.6	0
Mn	123	0
Ni	8.75	4.7
OH	<3.1	24,900
NO_3	9,870	2,090
NO_2	2,161	668
Pb	247	4,340
PO_4	805	287
Si	417	0.3
Na	7,215	2,680
Sr	<7.2	0
SO_4	443	119
TOC	106	0
U	<2,860	6,750
Zr	<14.3	0

Notes:

HDW = Hanford defined waste
NR = not reported.

[1]From Table D2-1.

Table D3-2. Comparison of Sample-Based and Hanford Defined Waste Model Estimates for Radioactive Components in Tank 241-T-102 (Decayed to January 1, 1994).

Radionuclide	Sample-based Inventory[1] (Ci)	HDW Model-based Inventory (Ci)
^{90}Sr	30,700	161
^{137}Cs	7,300	135
$^{239/240}Pu$	7.4	122

Note:

[1]From Table D2-2.

Note that significant differences exist between the sample- and HDW model-based estimates for Al, Ca, Cr, Hg, Mn, Ni, NO_3, NO_2, OH, Pb, PO_4, Si, Na, SO_4, TOC, and U. Among the radionuclides, substantial differences are apparent between ^{90}Sr, ^{137}Cs, and $^{239/240}Pu$. In the next section flowsheet, fuel production, and Waste Status and Transaction Record Summary (Agnew 1997a) will be used to independently evaluate the credibility of the sample- and HDW model-based estimates for this waste.

D3.1 WASTE TYPES

Generally, three different types of wastes were added to tank 241-T-102. The most important from a volume perspective are secondary PUREX coating waste (CWP2) and secondary cesium recovery (CSR) ion exchange waste.

D3.1.1 SECONDARY PUREX COATING WASTE

Approximately 1,836 kL (485 kgal) of secondary PUREX coating waste were added to tank 241-T-102 from 1964 to 1965 (in two batches from tank 241-C-102, with coating wastes remaining in this tank until a subsequent transfer to tank 241-T-103 in 1969). According to the HDW model, PUREX coating waste makes up about 89 percent of the sludge in tank 241-T-102, with the balance consisting of residual metal waste. Because tank 241-T-102 was a secondary receiver, one cannot predict from the flowsheet the absolute quantities of such waste that might have been added to this downstream tank. However, one can generate upper bounding estimates as if all of the components in this waste were routed directly to tank 241-T-102 (that is, assuming that tank 241-T-102 was the primary receiver of such wastes).

A spreadsheet analysis of the PUREX fuel fabrication and production records and waste transaction records (Agnew 1997) shows that 838.5 metric tons of uranium of (aluminum-clad)

PUREX coating waste were transferred to tank 241-C-102 and subsequently to tank 241-T-102 (in two batches of 40 kgal and 445 kgal each during the fourth quarter of 1964 and second quarter of 1965, respectively). The number of metric tons of uranium (MTUs) was computed by allocating the amount of fuel for each of these quarters based on the volumetric ratio of PUREX coating waste sent to tank 241-T-102 divided by the total volume of waste transferred to all of the tanks during these quarters. On this basis, tank 241-T-102 received 49.4 MTUs (809.6 gal/MTU) of secondary PUREX coating waste in 1964 and 789.1 MTUs (563.9 gal/MTU) of such waste in 1965. These values were derived from a spreadsheet analysis of the waste transaction records and fuel production records for the indicated periods, with the coating waste volumes (in gal/MTU) being computed from this data for each quarter. On average, about 404 gal/MTU of PUREX coating waste were produced, including flushes and dilution water, compared to the nominal flowsheet estimates of 250 to 350 gal/MTU.

D3.1.1.1 Silica. The aluminum alloy jacket around the fuel typically contains 0.046 kg Si/MTU, while the Al-Si braze metal used in the bonding layer adds another 1.269 kg Si/MTU (Kupfer et al. 1997). Therefore, the upper bounding limit for Si in the PUREX coating waste should be 1,102 kg (compared to the sample-based estimate of 417 kg and HDW estimate of 0.3 kg).

According to the PUREX flowsheet (Matheison and Nicholson 1968), 1,069 kg of Si were added to this tank based on 0.07 gmoles/L of Si in the concentrated coating waste (171.9 gal of coating waste per MTU of dissolved fuel) and correcting for the amount of dilution water in this waste (which increases the total volume to 809.6 gal/MTU for the 1964 transfer and 563.9 gal/MTU for 1965). For example, in 1964 151.4 kL (40 kgal) of such waste was transferred with 0.07 gmoles/L of Si diluted by the ratio of actual waste (809.6 gal/MTU) to theoretical waste (171.9 gal/MTU). Therefore, in 1964 only 63 kg of Si could have been transferred, while in 1965, 1,006.4 kg of Si could have been transferred to this tank. The total amount of Si (1,069.4 kg) is in close agreement with the fuel and waste transaction records derived estimate (1,102 kg). Unless all of the Si quantitatively precipitated in the first tank of the cascade (241-C-102), the sample-based Si estimate (417 kg) appears to be more reasonable value than the HDW estimate for this component (0.3 kg).

D3.1.1.2 Aluminum and Nickel. Other components were also contained in the PUREX coating waste, including 39,500 kg of Al and 395 kg of Ni (47.1 kg of Al and 0.47 kg of Ni per MTU, Kupfer et. al. 1997). Aluminum-clad fuels produced after 1959 contained about 1 percent Ni in the Al alloy jacket (Kupfer et. al. 1997).

Most of the Al was dissolved as sodium aluminate and transferred as such to one of the downstream receiver tanks. The upper bounding Al inventory can be estimated by subtracting the proportional amount of Al that precipitated in tank 241-C-102 (3,606 kg) from the total amount of Al transferred or added to tanks 241-C-102 and 241-T-102 in 1964 and 1965 (39,500 kg). The amount that precipitated in the sludge can be estimated by multiplying the total amount of Al added to tank 241-C-102 (97,000 kg) by the volume of coating waste transferred to tank 241-T-102 (485 kgal) divided by the total volume of such waste added to

tank 241-C-102 (13,044 kgal) (485/13,044 x 97,000 = 3,606 kg of Al) (Kupfer et. al. 1997). The results show that the upper bounding Al estimate for tank 241-T-102 should be 35,890 kg (39,500 - 3,606 = 35,894 kg) (compared to the sample-based estimate of 38,500 kg and HDW estimate of 10,200 kg). The sample-based Al inventory appears to be in good agreement with the upper bounding estimate for Al (38,500 kg compared to 35,890 kg). Because of atmospheric absorption of CO_2, and decreasing pH conditions in the supernatant, most of the Al in the PUREX coating waste supernatant must have precipitated over the five year period from 1964 to 1969.

In a parallel set of estimates for Ni, it appears that 395 kg of Ni from PUREX coating waste was added to tanks 241-C-102 and 241-T-102, but 326 kg apparently precipitated in tank 241-C-102 based on the best-basis inventory estimate (Kupfer et. al. 1997). By difference, approximately 69 kg of Ni may have been added to tank 241-T-102 from this source (compared to the sample-based estimate of 8.75 kg).

D3.1.1.3 Common Sludge Layers. Another approach that might be considered is to estimate the composition of tank 241-T-102 waste (a secondary PUREX coating waste receiver) based on the proportional amount of such waste in tanks 241-C-102 and 241-C-105 (both primary PUREX coating waste receivers). Tank 241-C-104 also received PUREX coating waste, but this waste only represents 56 percent of the total waste in this tank. In the other tanks, PUREX coating waste is thought to represent about 90 percent of the sludge in tank 241-C-105 and 85 percent of the sludge in tank 241-C-102. This approach also assumes that all of the waste transferred to tanks 241-C-102 and 241-T-102 actually precipitated in tank 241-T-102 (and therefore represents the upper bounding limit for such waste). These estimates were generated by multiplying the amount of each component in tanks 241-C-102 and 241-C-105 by the volume of coating waste sent to tank 241-T-102 (485 kgal) divided by the total volume of such waste added to tanks 241-C-102 (13,044 kgal) or 241-C-105 (3,151 kgal) (Kupfer et. al. 1997). The results are summarized in Table D3-3, together with sample and HDW estimates for tank 241-T-102 waste.

Table D3-3. Comparison of Common Sludge Layer Derived Estimates for PUREX Coating Waste in Tank 241-T-102 to Sample and Hanford Defined Waste Based Estimates for This Tank. (2 sheets)

Component	Tank 241-C-102 Based Estimates for Tank 241-T-102[1], kg	Tank 241-C-105 Based Estimates for Tank 241-T-102[2], kg	Sample Based Estimates for Tank 241-T-102[3], kg	HDW Model Estimates for Tank 241-T-102[4], kg
Al	2,910	2,360	38,500	10,200
Bi	126	25	<716	0
Cr	27	51	188	8
Fe	438	404	2,330	1,690

Table D3-3. Comparison of Common Sludge Layer Derived Estimates for PUREX Coating Waste in Tank 241-T-102 to Sample and Hanford Defined Waste Based Estimates for This Tank. (2 sheets)

Component	Tank 241-C-102 Based Estimates for Tank 241-T-102[1], kg	Tank 241-C-105 Based Estimates for Tank 241-T-102[2], kg	Sample Based Estimates for Tank 241-T-102[3], kg	HDW Model Estimates for Tank 241-T-102[4], kg
Pb	42	36	247	4,340
Mg	141	135	<143	NR
Mn	75	94	123	0
Ni	326	82	9	5
NO_3	2,020	844	9,870	2,090
NO_2	661	NR	2,160	668
PO_4	138	396	805	287
Si	1,770	1,520	417	0.3
Na	4,070	4,220	7,220	2,680
SO_4	171	<835	443	119
U	111	387	<2,860	6,750
Zn	452	0.6	103	NR
Zr	268	32	<14.3	0

Notes:

[1]Common sludge layer estimate based on tank 241-C-102 sludge composition multiplied by fraction of PUREX coating waste routed to tank 241-T-102 (485 kgal) divided by volume routed to tank 241-C-102 (13,044 kgal).

[2]Common sludge layer estimate based on tank 241-C-105 sludge composition multiplied by fraction of PUREX coating waste routed to tank 241-T-102 (485 kgal) divided by volume routed to tank 241-C-105 (3,151 kgal).

[3]Sample-based inventory estimate from Table D2-1.

[4]HDW based inventory estimate from Table D3-1.

Results in Table D3-3 show that sample-based estimates for Al, Cr, Fe, NO_3, NO_2, Pb, PO_4, Na, and U are higher than the common sludge layer derived estimates for PUREX coating waste. If the common sludge layer estimates are correct, these components must have been added from some other source, such as precipitation from B-Plant cesium recovery ion

exchange (PUREX supernatant waste [PSN] and REDOX supernatant [RSN]) waste or from PUREX coating waste supernatants. It appears, based on this analysis, that only 2,600 kg of aluminum could have been added with the PUREX coating waste sludge (average of tank 241-C-102 and 241-C-105 projections in Table D3-3). Perhaps another 2,300 kg might have been added by precipitation from the cesium recovery ion exchange PUREX sludge supernatant (PSS) waste (Table D3-4). The remaining fraction of Al (33,600 kg) must have been added by precipitation from the PUREX coating waste supernatants over the period from 1964 to 1969, or from cesium recovery ion exchange supernatants (PSN and RSN derived supernatants) added in 1972. A similar comparison also suggests that large quantities of Cr, Fe and PO_4 were probably introduced with the cesium recovery (CSR) ion exchange wastes.

Other components, such as Ni, Si, and Zr appear to be at lower concentration in the tank 241-T-102 than might be inferred from the common sludge layer estimates, which is expected for those components that readily precipitate in the primary receiver tank (241-C-102). For Mg, Mn, and SO_4, the sample-based estimates are very close to the common sludge layer derived estimates based on the primary receiver tanks. This indicates that the sample-based estimates for Mg, Mn, and SO_4 are in the correct range and on balance are likely to be more representative than the HDW estimates for these components (Table D3-3).

D3.1.2 SECONDARY CESIUM RECOVERY ION EXCHANGE WASTE

About, 1,851 kL (489 kgal) of secondary cesium recovery (CSR) ion exchange waste were transferred to tank 241-T-102 in 1972 (the last transfer to tank 241-T-102). In the B-Plant flowsheets for this process, two separate feedstocks were identified as cesium ion exchange feeds, high level PUREX supernatants (PSN) and more dilute PUREX supernatants from sluicing (PSS). Table D3-4 summarizes the average concentration profiles for these feeds, together with the estimated amount of each component that might have added in 1,851 kL (489 kgal) of PSN or PSS supernatant to tank 241-T-102. While the general source of the cesium recovery supernatants can be established from flowsheets, it is not possible at this time to determine the exact fraction of PSN and PSS in the final effluent stream to tank 241-T-102. However, based on B-Plant cesium recovery records, it appears that 80.6 percent of the feed during the second and third quarters of 1972 consisted of PSN and 19.4 percent REDOX supernatant (RSN), with small amounts of current acid waste (CAW). It cannot be established from these records the fraction of aluminum rich RSN that might have been transferred to tank 241-T-102.

Table D3-4. Projected Inventory of Secondary Cesium-Strontium Recovery Waste Added to Tank 241-T-102.

Component	PSS Waste Composition (*M*)	PSN Waste Composition (*M*)	PSS Inventory Added to Tank 241-T-102 (kg)	PSN Inventory Added to Tank 241-T-102 (kg)
Al	0.046	NR	2,300	NR
Cl	0.002	0.078	130	5,130
CO_3	0.71	0.73	78,900	81,100
Cr	0.0081	NR	780	NR
NO_3	0.92	0.52	106,000	59,700
NO_2	0.47	2.8	40,000	238,000
PO_4	0.031	0.013	5,450	2,290
Si	0.005	NR	260	NR
Na	3.8	5.15	162,000	219,000
SO_4	0.37	0.13	65,800	23,100

It seems clear from this comparison that cesium recovery supernatants contained much higher inventories of Cl, CO_3, Cr, NO_3, NO_2, Na, and SO_4 than indicated in the samples from this tank (Table D3-3). In all likelihood, these components probably remained in the 1,798 kL (475 kgal) of supernatant transferred from tank 241-T-102 to tank 241-S-110 in 1974. The small amount of Al in the PSS supernatant (2,300 kg) also suggests that most of the aluminum in tank 241-T-102 sludge was probably precipitated from the PUREX coating waste supernatant, or perhaps from the REDOX (RSN) supernatants processed through B-Plant during the first quarter of 1972. The modest amounts of Si in PSS waste and PO_4 in PSN waste in Table D3-4 are also consistent with the sample-based inventories for these components, 417 kg of Si and 805 kg of PO_4, compared to HDW estimates of 0.3 and 287 kg, respectively. Therefore, the cesium recovery PSN supernatants may have been a significant source of PO_4 and possible source of Si in the tank 241-T-102 waste.

D3.1.3 $BiPO_4$ METAL WASTE (MW)

Published sluicing records show that most of the metal waste was sluiced out of this tank in 1953 and 1956. However, a residual inventory of 7.6 kL (2 kgal) of metal waste is thought to have been left in the tank (Agnew 1997a, Anderson 1990). This residual inventory is generally consistent with the current analytical for this waste. According to these results, the current uranium inventory is less than 2,860 kg. This corresponds to a possible inventory of 5,610 L (1,482 gal) of metal waste, based on known composition of tank 241-T-101 metal waste (1.53 g moles of U/kg of metal waste) and assumed density of 1.74 kg/L (GE 1951, Agnew 1996). This volume of metal waste would be expected to contain 380 kg of PO_4 and 935 to 2,142 kg of CO_3 (0.51 g moles of PO_4/kg of metal waste and 1.92 to 4.4 g moles of CO_3/kg of metal waste sludge) (GE 1951). These estimates are not only consistent with the current analytical estimates for PO_4 and CO_3, but also indicate that a considerable fraction of the PO_4 and CO_3 must have been added with the residual metal waste to this tank. The current estimate for uranium (less than 2,860 kg) also appears to be consistent with the sluicing records from this era which indicate that 81,800 kg of uranium were left in tanks 241-T-101, 241-T-102, and 241-T-103 after the last sluicing campaign.

D3.2 CESIUM AND STRONTIUM

Tank 241-T-102 has an estimated heat load of 3,843 Btu/h or 1,126 watts (Kummerer 1995). This heat load corresponds to 238,600 Ci of ^{137}Cs or 168,000 Ci of ^{90}Sr, values that are well above the sample-based estimates for this tank (7,299 Ci of ^{137}Cs and 30,690 Ci of ^{90}Sr, decayed to January 1, 1994). In addition to other sources of cesium and strontium, a significant fraction of cesium may have been added from tank 241-T-101 during the third quarter of 1972 (through the REDOX supernatant from tank 241-SX-114). The sample-based inventory is equivalent to a heat load of 240 watts, based on a vapor space temperature of 24 °C (75 °F) and unknown waste temperature. Because the reliability of the tank 241-Thermal model has not been independently verified for this tank, it will be assumed for purposes of the standard inventory estimate that the sample-based estimates for ^{137}Cs and ^{90}Sr are correct. The sample-based estimates, on balance, seem to be more reasonable than the HDW model estimates for this tank (161 Ci of ^{90}Sr and 135 Ci of ^{137}Cs, also decayed to January 1, 1994).

D3.3 SUMMARY

The sample-based estimates for Si, Al, and Ni appear to be in the correct range and are generally consistent with upper bounding estimates developed from other sources of information, including process flowsheets, fuel and waste transaction records and the known composition of common sludge layers in other tanks. Sample results for Mg, Mn, and SO_4 are consistent with the composition of common sludge layers in other tanks, while Ni, Si, and Zr estimates are also consistent with the expected trend for secondary receiver tanks (that is, at lower concentration than in the primary receiver tanks). From the analysis of secondary

cesium recovery wastes, it was determined that projected inventories for Si and PO_4 are consistent with measured values in the tank 241-T-102 sludge. The analytical results for uranium also show that the residual metal waste inventory is consistent with the projected amount of residual metal waste in this tank (5,610 L versus 7,570 L) (Anderson 1990, Agnew 1996). Based on the indicated matches, it appears that the flowsheet and common sludge layer derived estimates support the credibility of the sample-based estimates for this tank. Moreover, this analysis shows that the HDW estimates for Al, Cr, Mn, PO_4, Si, and Na are low, and comparable estimates for Pb and U high with respect to sample-based inventories in tank 241-T-102 (Table D3-3). Sample-based estimates for ^{137}Cs and ^{90}Sr are generally consistent with the thermal modelling results for this tank, although the analytical results are considerably lower than might be expected from the thermal model. A significant fraction of ^{137}Cs may have been added from tank 241-T-101 during the third quarter of 1972 (through the REDOX supernatant in tank 241-SX-114).

Based on this comparison, the 1993 core sample (core 55) appears to offer the most reasonable and consistent set of estimates currently available for this tank. This sample will be used to develop the best-basis inventory for tank 241-T-102 because of the large number of analytical measurements (2,033), including 833 measurements for quality control and 230 for homogenization tests.

D4.0 BEST-BASIS INVENTORY ESTIMATE

Chemical and radionuclide inventory estimates are generally derived from one of three sources of information: (1) sample analyses and sample derived inventory estimates, (2) component inventories predicted by the HDW model based on process knowledge and historical tank 241-Transfer information, or (3) a tank-specific process estimate based on process flowsheets, reactor fuel data, essential materials records, or comparable sludge layers and sample information from other tanks.

An effort is currently underway to provide waste inventory estimates that will serve as the standard characterization data for various waste management activities. As part of this effort, a survey and analysis of various sources of information relating to the chemical and radionuclide component inventories in tank 241-T-102 was performed, including the following:

1. Data from one core sample obtained in 1993 (Pool 1993).

2. Component inventory estimates provided by the HDW model (Agnew et.al., 1996).

3. Evaluation of upper bounding estimates for secondary (Al-clad) PUREX coating (CWP2) waste and secondary cesium recovery (CSR) ion exchange waste, based on process flowsheets, fuel and waste transaction records for this tank.

4. Analysis of CWP2 sludge based on common sludge layers in tanks 241-C-102 and 241-C-105, together with waste transaction records for these tanks.

5. Analysis of residual metal waste based on the composition of tank 241-T-101 MW (GE 1951).

6. Evaluation of the estimated thermal loads provided by the sample-based inventories of ^{90}Sr and ^{137}Cs relative to thermal modelling results for this tank.

Once the best basis inventories were determined, the hydroxide inventory was calculated by performing a charge balance with the valences of other analytes. In some cases this approach requires that other analyte (e.g., sodium or nitrate) inventories be adjusted to achieve the charge balance. During such adjustments the number of significant figures is not increased. This charge balance approach was consistent with that used by Agnew et al. (1997).

Based on this analysis, a best-basis inventory was developed. The 1993 core sample was used to generate estimates for the chemical and radionuclide components in this waste. The waste in tank 241-T-102 primarily consists of secondary (Al-clad) PUREX coating (CWP2) waste, secondary cesium recovery (CSR) ion exchange waste and a small amount of residual metal waste (MW) from the $BiPO_4$ process. The best-basis inventory for tank 241-T-102 is presented in Tables D4-1 and D4-2. The inventory values reported in Tables D4-1 and D4-2 are subject to change. Refer to the Tank Characterization Database (TCD) for the most current inventory values.

Best-basis tank inventory values are derived for 46 key radionuclides (as defined in Section 3.1 of Kupfer et al. 1997), all decayed to a common report date of January 1, 1994. Often, waste sample analyses have only reported ^{90}Sr, ^{137}Cs, $^{239/240}Pu$, and total uranium, or (total beta and total alpha) while other key radionuclides such as ^{60}Co, ^{99}Tc, ^{129}I, ^{154}Eu, ^{155}Eu, and ^{241}Am, etc., have been infrequently reported. For this reason it has been necessary to derive most of the 46 key radionuclides by computer models. These models estimate radionuclide activity in batches of reactor fuel, account for the split of radionuclides to various separations plant waste streams, and track their movement with tank waste transactions. (These computer models are described in Kupfer et al. 1997, Section 6.1 and in Watrous and Wootan 1997.) Model generated values for radionuclides in any of 177 tanks are reported in the Hanford Defined Waste Rev. 4 model results (Agnew et al. 1997b). The best-basis value for any one analyte may be either a model result or a sample or engineering assessment-based result if available. (No attempt has been made to ratio or normalize model results for all 46 radionuclides when values for measured radionuclides disagree with the model.) For a discussion of typical error between model derived values and sample derived values, see Kupfer et al. 1997, Section 6.1.10.

Best-basis tables for chemicals and only four radionuclides (^{90}Sr, ^{137}Cs, Pu and U) were being generated in 1996, using values derived from an earlier version (Rev. 3) of the Hanford Defined Waste model. When values for all 46 radionuclides became available in Rev 4 of the HDW model, they were merged with draft best-basis chemical inventory documents. Defined scope of work in FY 1997 did not permit Rev. 3 chemical values to be updated to Rev. 4 chemical values.

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-T-102 (February 11, 1997). (2 Sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1]	Comment
Al	38,500	S	Tank 241-T-102 Sample Results
Bi	<716	S	
Ca	95.1	S	
Cl	70.3	S	
CO_3	3,690	S	
Cr	188	S	
F	42	S	
Fe	2,330	S	
Hg	0.8	S	
K	<530	S	
La	<71.6	S	
Mn	123	S	
Na	7,215	S	
Ni	9.00	S	
NO_2	2,160	S	
NO_3	9,870	S	
OH	<3.1	S	
Pb	247	S	
P as PO_4	805	S	
Si	417	S	
S as SO_4	443	S	
Sr	<7.2	S	
TOC	106	S	

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-T-102 (February 11, 1997). (2 Sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1]	Comment
U_{TOTAL}	<2,860	S	
Zr	<14.3	S	

Notes:

[1]S = sample-based, M = HDW model-based, E = engineering assessment-based.

Table D4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-T-102 Decayed to January 1, 1994 (Effective May 31, 1997). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M, or E)[1]	Comment
^{3}H	0.9	S	
^{14}C	5.9	S	
^{59}Ni	0.00214	M	
^{60}Co	<879	S	
^{63}Ni	0.206	M	
^{79}Se	0.00165	M	
^{90}Sr	30690	S	
^{90}Y	30690	S	based on ^{90}Sr
^{93m}Nb	0.00603	M	
^{93}Zr	0.00779	M	
^{99}Tc	2.3	S	
^{106}Ru	1.20 E-05	M	
^{113m}Cd	0.0306	M	
^{125}Sb	0.0398	M	
^{126}Sn	0.0025	M	
^{129}I	1.04 E-04	M	
^{134}Cs	<1.5	S	
^{137m}Ba	6900	S	based on ^{137}Cs
^{137}Cs	7300	S	
^{151}Sm	6.04	M	
^{152}Eu	0.0426	M	

Table D4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-T-102 Decayed to January 1, 1994 (Effective May 31, 1997). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M, or E)[1]	Comment
^{154}Eu	63	S	
^{155}Eu	70	S	
^{226}Ra	1.11 E-06	M	
^{227}Ac	0.0106	M	
^{228}Ra	0.00346	M	
^{229}Th	0.00157	M	
^{231}Pa	0.0157	M	
^{232}Th	1.61 E-04	M	
^{232}U	0.179	M	
^{233}U	0.694	M	
^{234}U	1.97	M	
^{235}U	0.0851	M	
^{236}U	0.0347	M	
^{237}Np	0.07	S	
^{238}Pu	4	M	
^{238}U	1.93	M	
^{239}Pu	7.4	S	
^{240}Pu	29.6	M	
^{241}Am	32.9	S	
^{241}Pu	320	M	
^{242}Cm	6.11 E-04	M	
^{242}Pu	9.01 E-04	M	
^{243}Am	3.32 E-07	M	
^{243}Cm	0.16	S	
^{244}Cm	1.26 E-05	M	

[1]S=Sample-based
M=Hanford Defined Waste model-based
E=Engineering assessment-based

D5.0 APPENDIX D REFERENCES

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J. S. Garfield	H5-49	X			
D. L. Herting	T6-07	X			
J. S. Hertzel	H5-61	X			
D. L. Lamberd	H5-61	X			
Pacific Northwest National Laboratory					
A. F. Noonan	K9-91	X			